Occurrence, distribution and genetic diversity of soil Phosphate Solubilizing Bacteria in soils of different chemical characteristics in Kenya

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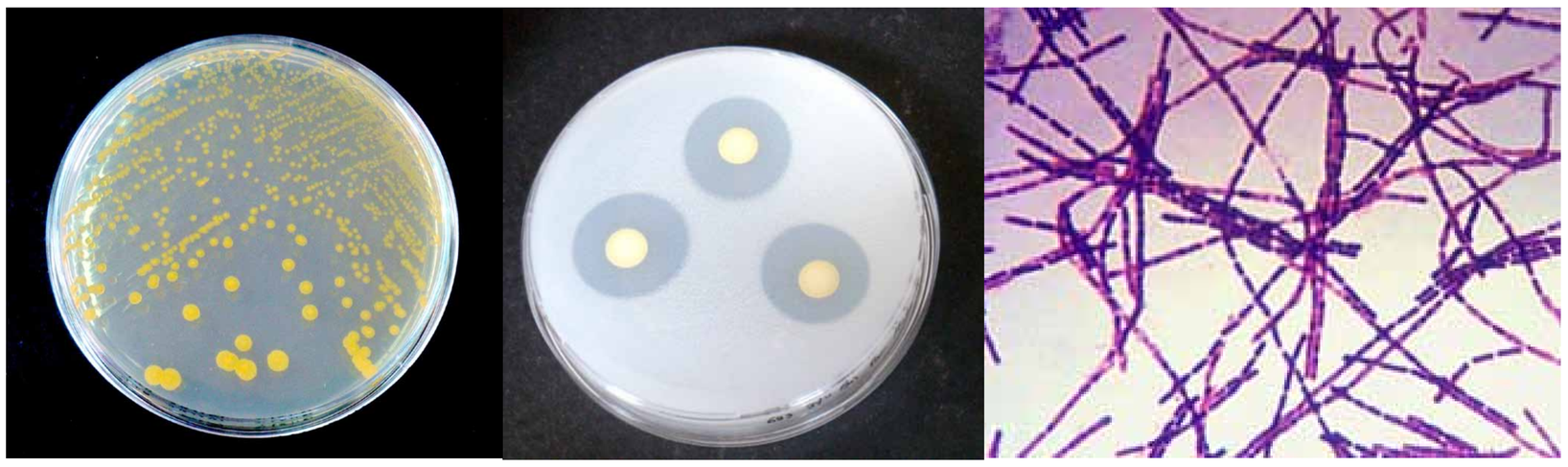
1. INTRODUCTION

Soil microbes play an important role in the ecosystem by enhancing mineralization of organic matter into inorganic forms for plant uptake (Setiadi, 1989). Phosphate Solubilizing Bacteria (PSB) are able to mobilize sparingly soluble inorganic and organic phosphates making it accessible to plants (Gyaneshwar *et al.* 2002). However, these PSB may not be present in sufficient numbers to compete with other rhizobacteria, or may not have a sufficiently high P solubilization potential (Vega, 2007) and therefore appear ineffective.



2. OVERALL OBJECTIVE

To determine the population and diversity of PSB present in Kenyan soils of differing soil chemical characteristics and assess whether they have a sufficiently high P solubilization capacity to be of importance for P availability for crops.

3. MATERIALS AND METHODS

Composite soil (0–15 cm) were collected from 12 sites in Kenya with a history of soybean production. The thoroughly homogenized soils were air-dried, serially diluted and plated on the National Botanical Research in Phosphate (NBRIP) medium (Mehta and Nautiyal, 2001). Phosphate solubilization efficiency was assessed in Frioni's medium (Frioni, 1999). Reference strains (MAN ID, PER 3A and PER 3C) acquired from Argentina (Fernandez *et al.,* 1997) were used for comparison. Identification of PSB was done through DNA extraction, PCR amplification and sequencing (Fankem *et al.,* 2006). Analysis of variance was conducted to ascertain the significance of PSM and PSB populations (CFU g^{-1} soil). The data on PSB populations in relation to soil properties was further subjected to Hierarchical Cluster analysis using multivariate analysis procedure of GENSTAT.

4. RESULTS

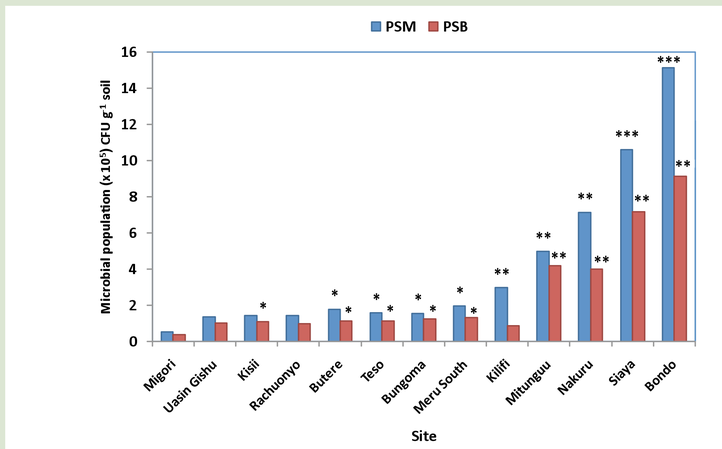


Figure 1: Population of Phosphate Solubilizing Microorganisms (PSM) and Phosphate Solubilizing Bacteria (PSB) isolated from different soils in Kenya. [*:- significant at p<0.05 **:- p<0.01]

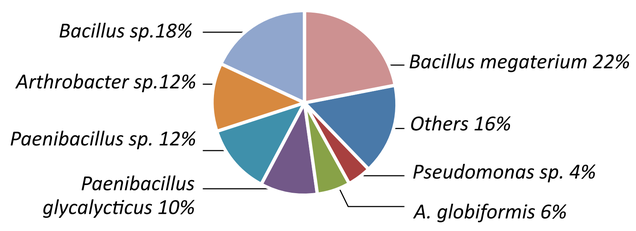


Figure 2: Distribution of Phosphate Solubilizing Bacteria strains across 12 Kenyan soils

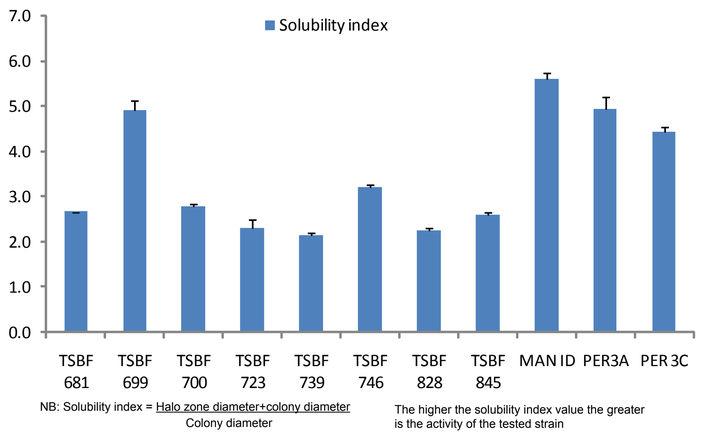


Figure 3: Comparison between phosphate solubilization potential of PSB strains isolated from bulk air-dried soils in Kenya and reference strains from Argentina

Table 1: Occurence of isolated PSB strains in Kenyan soils

	Rachuonyo	Butere-Mumias	Siaya	Teso	Kisii	Uasin Gishu	Migori	Mitunguu	Nakuru
Bacillus sp.	+	-	+	+	+	+	+	+	+
B. megaterium	+	+	+	+	+	+	+	+	+
B. flexus	-	-	-	-	+	-	-	-	-
B. subtilis	-	-	+	-	-	-	-	-	-
Pseudomonas sp.	-	-	-	-	-	-	-	+	-
P. oryzihabitans	-	-	+	-	-	-	-	-	-
Paenibacillus sp.	+	-	+	-	-	+	+	+	-
P. glycalycticus	-	-	+	-	-	+	+	+	+
P. polymyxa	-	-	+	-	-	-	-	-	-
Arthrobacter sp.	+	-	+	+	-	+	-	+	-
A. globiformis	+	+	-	-	-	-	-	+	-
A. ramosus	-	+	-	-	-	-	-	-	-
Bulkhoderia sp.	-	-	+	-	-	-	-	-	-
Williamsia sp.	-	-	-	+	-	-	-	-	-
Micrococcus lutues	-	-	-	-	-	-	+	-	-
Microbacterium sp.	-	-	+	-	-	-	-	-	-

Where: +: strain present in the soil and
–: strain absent in the soil

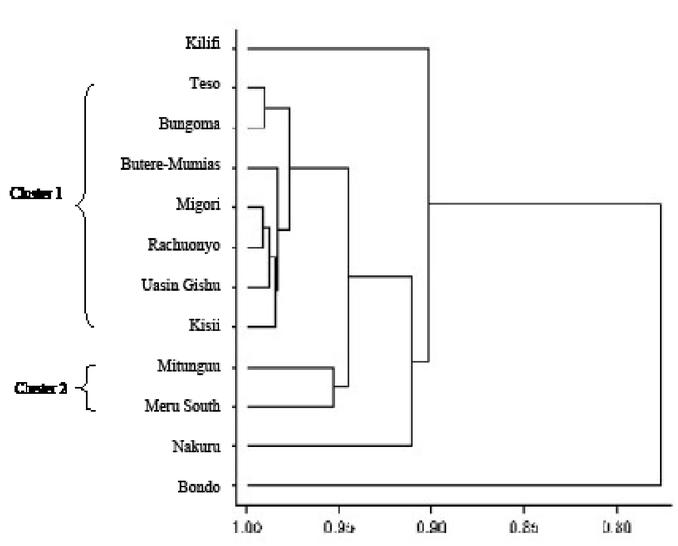


Figure 4: Cluster analysis of soil samples using nearest neighbor in the Hierarchical Cluster analysis. The scale represents the Euclidean distance of soils samples as an index of their similarity

5. SUMMARY

Population of PSM and PSB differed significantly ($p<0.05$) with sites (Figure 1), with Nyanza, Siaya, Nakuru and Mitunguu soils having the highest PSM / PSB ratio respectively. Spore forming Bacillus sp and B. megaterium were the most abundant (Figure 2) and well distributed PSB strains (Table 1), but were not effective P solubilizers, showing the need for inoculation with efficient strains to improve P availability. TSBF 699 (Bulkhoderia sp.) was highly effective, with high solubilization potential (Figure 3) and formed halo diameters of between 20-50cm after 4 days of incubation. de Freitas et al. (1997) reported high P solubilization in strains with halo diameters of >15cm. Hierarchical cluster analysis between soil properties revealed two classes (Figure 4), but Kilifi, Nakuru and Bondo soils were distinctively different from the other soils. Since the identified PSBs are heterotrophs, soil organic C and total N influenced the clustering, soils with similar levels of C and N clustered together, showing the importance of organic matter in soils.

6. CONCLUSIONS AND RECOMMENDATIONS

- PSB population and diversity differed among the soils depending on organic C, total N and exchangeable Ca content of the soils.
- The metabolic activity in PSB isolated from air dried bulk soil is highly reduced; only 5% of isolated strains maintained their P solubilizing capability.
- Further assessment of the P solubilizing capacities of persistent PSB and their interaction with crops should be done.
- The effective strains (TSBF 699 and TSBF 746) will be compared with other reference strains and commercial products containing PSB to confirm their efficiency in plant growth improvement.

7. REFERENCES

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8. ACKNOWLEDGEMENT

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